76. Nutrient Stoichiometry Drives Carbon Turnover and Microbial Community Composition in Mineral and Organic Soils Under Rice Cultivation

Wyatt H. Hartman1, Rongzhong Ye2, William R. Horwath2, Susannah G. Tringe1* (sgtringe@lbl.gov)

1DOE Joint Genome Institute, Walnut Creek, CA; 2Department of Land, Air and Water Resources, University of California, Davis, Davis, CA

Project Goals: We aim to characterize the microbial communities in wetland environments and evaluate their impact on carbon cycling, in order to develop strategies for optimizing carbon sequestration. Here we sought to determine the impact of soil carbon, nitrogen and phosphorus on carbon turnover and microbial community composition in an experimental rice field system.

Inundation of soils combined with emergent vegetation growth may enable high rates of soil carbon sequestration, and both rice cultivation and wetland restoration have been proposed as strategies to enhance carbon storage and reverse subsidence in degraded agricultural soils of the Sacramento-San Joaquin Delta. To isolate effects of wide variation in soils of the Delta on belowground C turnover, we studied a series of rice field trials as a model system with controlled vegetation and hydrology. Although soil C cycling may depend on the availability of carbon (C), nitrogen (N) and phosphorus (P), the role of P is particularly poorly understood due to a historical emphasis on soil C:N ratios informed by terrestrial nutrient limitation. To determine the effects of N and P availability on soil C turnover, we compared soil respiration over the course of a growing season in four adjacent rice fields with 5%, 10%, 20% and 25% soil C, each with control and N addition treatment plots (80 kg N/ha urea). Although soil P was not manipulated in parallel, prior work has shown soil P concentrations decline markedly with increasing soil C content. Soil CO2 and CH4 fluxes were monitored using static chambers at biweekly intervals during the growing season, and soils were collected at the end of the growing season for biogeochemical analysis and DNA extraction. Seasonal CO2 fluxes (per m2) were highest in 10% C soils (N:P =16:1), while soil N addition increased CO2 flux and soil C turnover (seasonal CO2 flux per unit soil C) in lower C fields (5% and 10% C), but not in higher C fields (20% and 25%). These patterns may be more clearly interpreted in light of shifts in soil N:P stoichiometry, which increased with soil C pools. Soil carbon turnover was greatest in mineral soils and inversely related to soil N:P ratios, suggesting progressive P limitation might limit both soil metabolism and its response to N at higher levels of soil C. Microbial community composition, based on 16S rRNA sequencing, was strongly influenced by soil C and pH along the gradient, but not by N additions as commonly observed in upland soils. Like soil carbon turnover, bacterial communities were also closely linked with soil N:P and inorganic P, and these relationships were significant even after accounting for covariance with soil C and pH. Functional gene content inferred from microbial phylogeny suggests substantial shifts in the potential to utilize carbon and phosphorus substrates between low and high C soils. Our results show that soil P availability and stoichiometry may affect microbial communities and their mediation of soil C turnover, even where primary producers appear limited by N.

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